PEST TECHNOLOGY

PEST CONTROL AND PESTICIDES

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PEST TECHNOLOGY is published for the interest of everyone concerned in the control and prevention of all kinds of infestation in agriculture, marine and harbour installations, food manufacture and distribution, hospitals, and all kinds of domestic, commercial and industrial premises. It is read in more than seventy countries by agricultural merchants and millers, food suppliers, farmers, research institutions, shipping companies, port authorities, pest control officers, spraying contractors and medical authorities.

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RESEARCH AND EXPERIMENT

A monthly digest of reports of significant trends and investigations in all fields of weed and pest control and wood preservation operations.

Organising Research in Africa

A SYMPOSIUM to examine various aspects of the organisation of agricultural research in Africa was being held earlier this month, at the recommendation of the Commission for Technical Co-operation in Africa.

The object of this symposium was not to establish an identical pattern applicable to all countries, but to provide people responsible for agricultural research with information on the various methods for dealing with organisational problems which arise in this kind of work. Such an exchange of information is particularly appropriate at this time when a number of new African states are considering the reorganisation of their research services.

The agenda of the symposium, which was held at Muguga, Nairobi, included general discussions on the objectives of research work of agricultural organisations, the structure of such bodies and the problem of liaison. Particular attention was paid to liaison between institutions where research is being undertaken in or outside Africa and with the technial and administrative departments including those for agricultural extension.

Two vital aspects which were being emphasised at the meeting were (1) the avoidance of duplication of activity, thus making best use of men and money in Africa, and (2) how to ensure that beneficial results of research findings are rapidly made available and put into application by peasants and farmers.

Fumigation Standards in Europe

SOME TIME AGO the European and Mediterranean Plant Protection Organisation set up a working party to investigate fumigation standards in regard to living plants, flowers and seeds, roots, tubers and corms, which could be recommended for international adoption. This followed a suggestion that it would be a great help to exporters if other countries could follow the example of Britain which defines (through its Importation of Plants Order) the method of fumigation to be adopted in dealing with these commodities.

Although the working party think it is premature to try and recommend specific fumigation standards in its report, it has put forward certain principles which should be followed in drawing up fumigation schedules, and which would be acceptable on an international scale. They are as follows:

1. Every schedule should be based on the appropriate CT (concentration × time) product. The value of the CT product which appears in a schedule must apply to a specific pest occurring in a particular plant material fumigated under definite conditions. It must ensure that the pest concerned anywhere in the plant material is fumigated at a lethal concentration.
2. The values of the lethal CT product and of the CT product prescribed in the schedule should be based on a well-designed series of fumigation experiments in which determinations are made not only of the concentrations of fumigant around the pest at prescribed locations relevant to practical treatments, but also of the percentage of kill actually obtained.
3. The precision required in prescribing a CT product would vary from instance to instance, depending on the susceptibility of the plant material and the CT product required to give effective control.
4. In preparing a schedule, all relevant conditions — biological, physical and chemical — must be included.
5. Every schedule should state a CT product above which plant injury or objectionable residues may be expected.
6. When treatments prescribed in schedules are being given for plant quarantine, where the overriding objective must be to secure complete control of the pest, the fumigation must be carried out in sufficiently gastight chambers equipped to secure proper delivery, distribution and removal of the fumigant.
7. For purposes other than those referred to in point 6, the adoption of CT products as the basis of dosage permits the use of other enclosures such as stores, barges and gasproof sheets. In such fumigations, gas concentrations must be determined and the dose and time adjusted so as to secure a CT product lying within the values prescribed in the schedule.
8. Training in methods of determining gas concentrations is essential in order to avoid any risk of error in fumigation based on the CT product. The methods to be used will vary from one fumigant to another and will be improved in accuracy or convenience from time to time.
9. Any schedule based on the results of experiments should be accompanied by a citation of the published report of the experiments, whenever available.
10. Where proper information on CT products is not yet available, temporary schedules may exceptionally be based on practical experience of fumigations in sufficiently gastight non-absorptive chambers.

Finally, it is suggested that EPPO should appoint a standing committee to examine fumigation schedules and those approved would be sent to member countries and to the FAO.

Treating Timber for Farms

ADVICE TO FARMERS on the ways in which treated timber can become eligible for grants under the Farm Improvement Scheme is given in the October issue of the British Ministry of Agriculture's magazine, *Agriculture*.

"It does not seem to be generally understood that the degree of protection obtained depends in general," says the article, "more on the depth to which a preservative is forced into the wood than on the type of preservative used. There are five ways of applying preservative. In order of efficacy they are: pressure treatment, 'hot and cold' treatment in an open tank, steeping, dipping and brushing (or spraying). There are many excellent preservatives on the market but some of them for various reasons are not applied in this country by pressure or by the 'hot and cold' method.

"Because the Ministry looks for permanent improvements, it has to insist on lasting protection; so only the more efficaceous methods are allowed, namely, treatment by pressure or by the 'hot and cold' method. Applicants' proposals (for grants) are not infrequently turned down because the *method* of application is unacceptable, not the preservative. It is true that the Ministry can allow other methods, but it does so only in exceptional circumstances.

"For the do-it-yourself man" says the article finally, "the 'hot and cold' method, properly done, is most satisfactory."

A New residual pre-emergence weedkiller has been developed for use by sugar beet growers. Some of the results it helped to achieve are shown in this picture. Based on endothal and propham, it can be used on most soils ranging from medium loam to light sand. During trial application, of thirty-seven common weed species listed, only three (orache, charlock and white mustard) were relatively resistant. Fat hen, which is closely related to sugar beet, is on average reduced by 50 per cent.

The weedkiller is called Murbetex, and has been developed by Murphy Chemical Co. Application to the field illustrated above was by special Dorman band sprayer.

Eelworms and the Sports Ground

HOW MUCH DAMAGE do eelworms cause to sports turf in this country? asks a writer in the *Sports Turf Bulletin*, published by the Sports Turf Research Institute. He then goes on to say that too little is known about their effect. *Ditylenchus radicicola* is a nematode that has a widespread occurrence in Britain, and very heavy infestations causing severe gall formations on the roots of annual meadow grass have been recorded without the plants showing any signs of damage on the surface. Only in prolonged drought do the infested plants show symptoms of the attack and their normal seasonal die-back may be advanced slightly.

Free-living root-parasitic nematodes occur in turf but the extent of the damage done by them is not known, says the article. Both Vapam and Mylone have been very encouraging in tests as a pre-treatment to seeding. Since these materials also kill weed seeds and some soil fungi as well as nematodes, the beneficial effect of the materials in increasing the stand of grass seedlings cannot be attributed directly to suppression of nematodes.

As yet, says the article, no materials have been tested on established turf for nematode control and it seems likely that those in use in the USA will not be of use in Britain since the high soil temperatures are needed for them to be effective.

Herbicides Help to Form Firebreaks

ALTHOUGH A SHORT GRASSY SWARD is now generally preferred for purposes of a firebreak by the Forestry Commission in Britain, bare soil breaks are still important where the ground precludes the use of machinery, or where low rainfall and infertile soils will not support the grass all the year round. If their disadvantages of high cost and loose soil conditions could be overcome they would probably be used more widely. Herbicides provide a means of maintaining bare soil without cultivation, and during 1956—59, a series of trials was carried out to assess the effectiveness, safety, persistence and probable cost of herbicides over a range of soil conditions. An account of these trials is given in the annual report just published by the Forestry Commission for the year ended March, 1960.

The trials were made on three contrasting soil and vegetation types, i.e. sand, clay and chalky loam. The compounds selected for use included monuron, diuron, crude sodium borate, borate/monuron, sodium chlorate, borate/chlorate, simazine, sodium arsenite, sodium TCA, borate/2,4 D, and chlorate/MCPA.

In general it was found that the borate compounds, including borate ore, borate/monuron and borate/chlorate were effective total herbicides and it is possible to achieve complete soil sterilisation for two seasons at high rates on soils which are not calcareous. On the whole, results were better on light than on heavy soils but the differences were not great. Borates generally were least effective against perennial grasses, and high rates, or admixture with monuron, were necessary to control this group.

The monuron and diuron compounds proved effective and persistent against perennial grasses. At medium rates the compounds were successful in producing fireproof breaks by alteration of the species composition to broadleaved herbs. These compounds were less affected by high soil-base-status than borate chlorate, and there was little to choose between monuron and diuron in persistence on sand and clay.

Simazine was not tested in strict comparison with other herbicides, but results suggest that its effects are similar to monuron and rather more persistent.

Sodium arsenite, sodium chlorate and sodium TCA all proved "rather disappointing", mainly because of their limited persistence even at high rates.

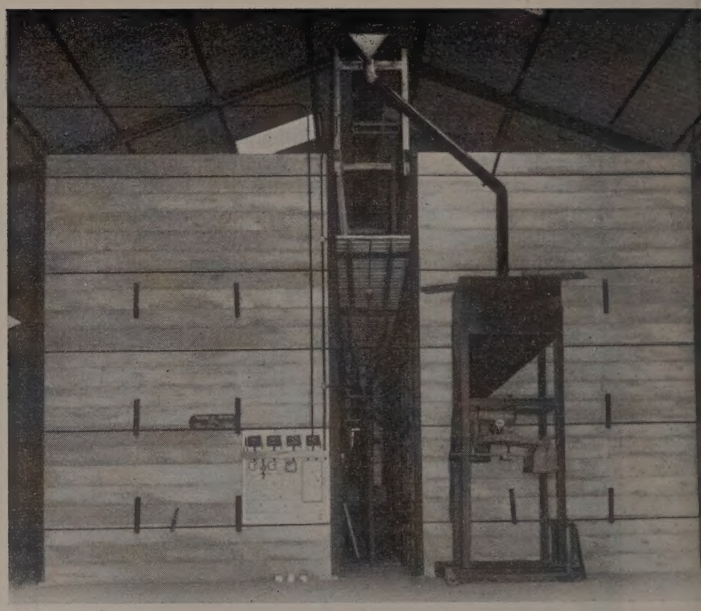
There were wide differences in the degree of control and persistence achieved with each herbicide, according to the soil conditions concerned. The most striking result was the depression of herbicide effectiveness on the highly calcareous soil. Under these conditions the efficiency of borate, chlorate, arsenite and TCA salts appeared to be reduced, while monuron seemed less effected. It seems possible (says the report) that reduced phytotoxicity on this soil is associated with a high level of free calcium carbonate, which may reduce the concentration of active anions, by forming compounds of lower solubility.

Comparison of herbicides on sand and clay soils showed that most commonly results were better on sand than on clay.

On the whole, the most satisfactory results were obtained with monuron or simazine, the treatments being monuron at 20 lb. (active) per acre plus annual maintenance treatments of 10 lb. per acre, or simazine at 10 lb. (active) per acre plus 5 lb. per acre maintenance treatment. For control of germinating annual weeds on bare lands these rates could be reduced to half. The investigation found there was little to choose between these herbicides in cost, i.e. £30—£40 per acre formation and £15—£20 per acre maintenance costs. Advance cultivation is not necessary with these compounds, although this is preferable for a reduced fire hazard and assistance in weed suppression.

INFESTATION OF STORED GRAIN ON BRITISH FARMS

By J. S. C. Dealey



A grain silo system designed by Goodes of Royston—two rows of five precast concrete bins, each 12 ft. square and 18 ft. high, giving a capacity of 500 tons.

The author, who is a specialist in the control of insects and mites in grain and seed stores, offers some disturbing observations on the present attitude to scientific control widely found in Britain.

THE loss of harvested grain through infestations by insects and mites is one of the most serious sociological matters in the world. It is estimated that a tenth of the annual world production of cereals and seeds is destroyed, or rendered unfit for use, by such pests.

Since quite a high proportion of the human race is existing at approximately starvation level, the current loss of 2 cwt. per ton per annum is not one lightly to be dismissed. If the loss could be halved no one in the world—statistically speaking—would need to go hungry. Cereals and seeds are the staple of almost every community, even the Masai and the Esquimaux depend to some extent nowadays on such foods, and the great population masses of Asia, Europe and America, of Africa and Australasia, depend on the safe storage of seed harvests for their existence.

The war between mankind and insect has been waged without a halt for thousands of years; for example, the early Egyptians used silicates in their stored corn, to scratch the moisture-proof coatings of the beetles that attacked the seeds. These scratches caused the adult beetles to die of dehydration—perhaps the first example of a contact insecticide being used for the protection of stored grain.

But the battle against insect pests is still a long way from being won and in tropical and subtropical climates, and especially those with high humidity, losses of stored foodstuffs today are much heavier than 10 per cent. a year. In Britain the national loss in store is estimated at 5 per cent. This is largely due to its climate, and not to its storage methods being twice as efficient as those of other peoples.

It is not generally appreciated just how high a proportion of our national grain crop is stored on the farm. Every year, for at least the last fifteen years, our farmers have produced bigger and better crops per acre. Improved machinery, improved seed strains, herbicides, pesticides, fertilisers—all have played their part in increasing yields. So has the economic factor.

Today's farmer, faced with falling prices, cannot retrench like his father or grandfather did. He may no longer withdraw into his shell, until bad times pass. He must improve his methods, extend his outlays, and increase production.

All these factors, then, accumulate to produce larger crops, and since the combine harvester is used

for most of Britain's cereals, the harvest goes into store for the most part, already threshed. The stack—the corn-rick—has almost disappeared from the English countryside. Storage is almost all in bulk.

Development by trial and error

This is not just a point of agricultural history. The corn-stack is a product with many hundreds of years of experience behind it. By trial and error, by thought and observation, the British farmer developed a construction that has become—within the limitation of its materials—a near-perfect method of storing grain.

Now, within the span of a decade or so, he has to devise storage plants for threshed grain, in ever increasing quantities, and in many cases by adapting and extending old buildings. In current jargon, he is back to square one, but on a different board, and with many different rules.

Storage may be loose, in bulk on floors, or in sacks, or in bins or silos.

However it is stored, it must be sheltered from the weather, and so it becomes the perfect target for attack by the legions of insect and mite pests. A location packed with almost limitless food, without predators, without climatic extremes, rainproof, windproof and frostproof. Sooner or later, **every** farm store will harbour insects and mites.

Of some 4,000 farm stores surveyed by the writer over the last twelve years, less than 1 per cent. were free from any actual or potential infestation. One wonders whether the estimate of cereal losses in this country may not in fact be closer to the international average than the figure of 5 per cent. that has been accepted for so long.

Let us, however, consider the implications of even a 5 per cent. loss. Statistically, it means that every farmer loses on average one entire harvest every twenty years, or that every ton he grows must pay a tax of 1 cwt. to these pests. Like most taxes, this can ill be spared, shows no return, and has no compensation.

Infestation unpredictable

Infestation of grain is not always predictable, nor does it follow, because a farmer has modern plant and first-class equipment, that he will be less liable to trouble from pests than his neighbour, who houses undried corn on an earth floor in an ancient thatched barn. The writer's own statistics show that just as many serious infestation occur per hundred modern plants as per hundred stores in converted buildings. This is perhaps an unpalatable fact, but a fact all the same. The only consolation is that a well-designed modern store is much easier to disinfest than a series of old barns with innumerable crevices to shelter pests.

It may be that insects tend to be cyclic in their appearance. In 1950 the grain weevil (*Sitophilus granaria*) was a prominent pest of all types of store. Today he is to be seen far less frequently. In 1953 the writer found that the saw-toothed grain beetle (*Oryzaephilus surinamensis*) was the cause of 60-70 per cent. of the infestations visited, and today this pest is the cause of nine infestations in every ten. Yet in the 1940's the Australian spider beetle (*Ptinus tectus*) was considered one of the most common insects attacking cereals in store. Today he is a rarity in farm stores, and in twelve years the writer has never seen the species in any significant numbers on any farm.

Changes brought about by research

Of course the developments in insecticidal research may have been responsible for many changes in the pattern of infestation, though it should be mentioned that spider beetles (*Ptinidae*) are relatively resistant to most formulations of contact insecticide. Until the advent of malathion the same could be said for the sawtoothed grain beetle, and yet one species has increased and the other has largely disappeared.

Cryptolestes species (syn. *Laemophloeus* spp.) were fairly commonly met with in farm stores ten years ago. The writer noted in his summaries at the end of 1956 "*Laemophloeus* spp. almost never seen nowadays, only four significant populations noted this year, out of 339 stores seen". Yet in 1961 the species was seen by the author in reasonably heavy populations in eighteen infestations, though not all these infestations were primarily by *Cryptolestes*.

Different types of store, of course, support different species. The Khapra beetle (*Trogoderma granarium*) is almost never found on the farm, but is still a serious pest of maltings. The "flour beetles", *Tribolium castaneum* and *T. confusum*, are quite serious pests in many commercial stores, and though they are still found from time to time on farms they seem to occur there less frequently and in fewer numbers.

Moths tend to be selective, and, so far as farms are concerned, the species that cause such trouble in commercial warehouses are not often likely to set up infestations. Since *Ephestia kuhniella, E. elutella*, etc., are all too common in Britain, it is odd that they have not adapted their lives to farm conditions. Their place is taken, in most farm stores, by two indigenous species, *Endrosis lactella* and *Hoffmannophila pseudospretella*. These two species are common to most of Britain, and are fairly omnivorous, if one may use the term. They have developed remarkably large populations in farm stores that have been untreated for years, and the larvae appear to feed on cereals that have been milled,

crushed or only slighily damaged during combining and the mechanical processes that follow. Both species also attack dried peas and beans, and here they would appear to do more damage, in a shorter time, than is evident when cereals only are available. These moths may well be far short of peak populations in farm buildings, and may become primary pests of some stores in a few more years. However they have not the ability to develop immense populations within a single storage season (August to May/June) like the saw-toothed grain beetle, and control is relatively simple since their penetration of a bulk of grain is very shallow. They are, however, distinguished as being the only **insect** pests that can enter stores, in any numbers, by their own efforts. For although the "rice weevil" (*Sitophilus oryzae*) is found at times in farm stores he has not yet been recorded as flying there. In tropical countries, of course, this insect flies to standing corn, and from the field to the warehouse.

Apart from insects, mites are often very serious pests of bulk cereals. In 1955 the writer saw a new store heavily infested by mites within a few weeks of harvest. The incident was remarkable in that the store was quite new, absolutely clean, and completely insulated, geographically, from any other store. On three sides were conifer plantations, many miles in depth, and on the fourth side was the North Sea. No purchased cereals had ever been introduced into the store, and every bin had its own drying unit. The incidence of Tyroglyphid mites in soils had not, so far as could be established, been studied in this country, and the writer's soil-sampling tests were in progress when another odd infestation by mites was reported fifty miles away. Here quite amazing volumes of mites (measurable in cubic feet of mites per day) were emerging from a small quantity—less than 2 cwt.—of new hay stored in a manger. Three main type species were identified, and samples taken from the surface soil, the subsoil, the aftermath and the stack, in the field where the hay had been cut, all contained large numbers of all three species. All are commonly found infesting bulk grain.

Preference for light soils

From samples taken in every store visited since (some 2,000 or more) the writer has found that the incidence of mites is, generally speaking, directly relative to the type of soil on the farm. Crops from light soils often show numbers of mites quite soon after harvest, crops from heavy soils seldom yield any significant numbers of mites, though such crops can of course develop such numbers in course of storage.

Partly because they are able to breed very rapidly, partly because their small size enables them to escape inexperienced examination, the mite is a considerable danger to grain in bulk, and since it attacks the embryo of the grain first, losses are far heavier than a perfunctory examination would lead one to suspect. Viability of "quality" grain—i.e. seed corn, malting barley, milling wheat—is of fundamental importance, and it is from the sale of quality grain that the cereal farmer expects his profits.

Attack not limited to grain

Not only grain is attacked by mites. Oily seeds such as brassicas, clovers etc., and on occasion sugar beet seed, can be very heavily attacked, and with such valuable material losses can well be startling.

A great deal needs to be learned about these pests. Already the bibliography on *Tyroglyphids* suggests that heavy infestations do more than taint the food. Mite-contaminated diets have been blamed for digestive, optical, respiratory and epidermic disorders in man and in many animals, in some cases with fatal results. The miller calls mitey grain "minty", and certainly the smell of a *Tyroglyphid*-infested bulk is easily detected by the nose, though the term "minty" seems inaccurate, since the smell has none of the astringency of mint but rather the sickly sweet smell of corruption. The taint is retentive, and persists indefinitely, even if the infestation is destroyed by chemical or other means.

Mites are resistant to most insecticides. Since they are not insects this is reasonable enough. Lindane, however, is quite effective if applied in sufficient strength, but on the farm the best control is probably thorough heat-drying, and just as thorough a cooling of the grain afterwards. In the case of sugar-beet seed, of course, lindane is not permitted by the British Sugar Corporation, as a treatment of seed, and careful storage is the only safeguard.

The farmers' dream

Wherever foodstuffs are bulk-stored, the entomologist will be asked for a prescription. This is inevitable. The prescription will be for a material that will kill all insects and mites of every type species, and will protect the material indefinitely. Hard-headed businessmen, farmers with, for example, a good working knowledge of the intricacies of veterinary medicines, of bacterial and virus control, even farmers with considerable scientific training (by no means a rarity in these days), all seem to be convinced that somewhere, on someone's shelf, lies a tin of this stardust that will slay all pests, keep the store free indefinitely, cannot taint, has no toxic effects on mammals, and is remarkably inexpensive; and, they feel, can be used without hindering the routine work in the store.

In fact such a preparation is as remote as some

golden capsule—free, and from the National Health Service—that will prevent or cure any known disease or ailment.

An expensive answer

Insects and mites are selective in their poisons, and there can be no alternative to experienced advice, where control, and to a lesser extent prevention, are required. Fumigation is often the only answer, but it is not one that can appeal to the farmer, for fumigation is too often a heavy additional cost to an already crippling loss. Fumigation implies salvage, and grain that has required fumigating is very seldom sold for anything but feedingstuffs.

Obviously every miller and maltster, merchant and farmer cannot have an experienced entomologist on their staff. Recommendations must be general if they cannot be particularised, and the advice to farmers to clean out and spray their stores every year is excellent. But to spray with what? Malathion is obviously a first choice, since it can control *Oryzaephilus*, presently the most serious pest of all. But the writer feels that a standard mixture of compatible insecticides would be more useful. A malathion/lindane spray, for example, can kill a wider range than either insecticide used alone, and in practise a DDT/lindane spray is possibly one of the most durable and widely-reaching mixtures for the farmer to use.

But any whole-hearted spray- and cleaning- programme by the farmer is good, whatever the material employed. The man who takes all possible precautions against infestation, without ever having experienced such a visitation at first hand, is a wise and progressive farmer. Unhappily he is still a very rare bird.

When one reflects on the time, care, experience, thought and money that must be expended before a cereal crop can come to harvest, it is little short of tragic that ignorance, laziness, meanness or just illogical optimism still prevents seven farmers in every ten from doing anything to protect it during storage, especially when the storage period may be longer than the growing period.

PRESERVATIVE TREATMENT OF RAILWAY TIMBERS IN GERMANY

By Dr. Georg Schulz *

This paper was originally delivered last summer at a conference of the British Wood Preserving Association.

AT present there are about 110.5 million sleepers in use in the tracks of the German Federal Railways; of these about 51 per cent. are wooden sleepers.

The most commonly used species of wood for sleepers changed to some extent in the course of the years, caused partly by the development of impregnation techniques and partly by the indigenous forests and their composition of species. After foundation of the railways in Germany oak sleepers were favoured until the end of the last century, of which 54 per cent. were laid in track even in 1880/81 without preservative treatment.

Beech wood did not become fully usable before the invention of the so-called Rueping empty-cell process, for without preservative treatment this species, which does not have a natural decay resistance, has only about three years useful life in track, and the full-cell treatment with creosote turned out to be too expensive because of the high absorption of preservative.

* *Deutsche Bundesbahn, Bundesbahn-Zentralamt Minden (Westf.).*

Oak is prevalent in the field of switch ties. Beech sleepers, which could be supplied alternatively for the shorter lengths in former times, are not used nowadays since beech necessitates another impregnation method other than oak. This, however, interferes with the continuous flow of work of the treatment of a sleeper unit. Pine switch ties are normally used for second-class lines and provisional constructions only. However, during the past two years Bongossi-sleepers have often been built into switches for highest traffic conditions.

Protection of wooden sleepers

The protection of the timber for sleepers does not start with the chemical treatment in the impregnation plant but in the forest when a tree is cut down. This concerns especially beech wood which is imperilled with regard to the formation of tyloses in the vessels as well as to an attack by wood destroying fungi. A thorough penetration of the timber is the basis for a long life in service later on. This, however, in the case of beech sleepers is only possible if the pores of the wood are not blocked by tyloses, for with beech wood, only the impregnation from the cross sections is practically effective. Therefore it is necessary to arrange cutting, conversion and treatment of beech wood so that tyloses cannot grow intensively and that the wood remains penetratable.

The formation of tyloses increases at temperatures above 15° to 20°C. and with slow seasoning of the timber. This is counteracted by cutting and conversing the timber in winter only, if possible.

The DB (German Federal Railways) support these efforts and demonstrate its importance by granting a premium on sleepers of group I, when these are supplied until the end of February or the end of April, respectively, on condition however, that at the final date, i.e. 30 June, 95 per cent. of all sleepers of group I have been delivered. After 30th June principally no more beech sleepers are taken over as it cannot be guaranteed, especially when it is warm, that the sleepers are still impregnatable and not infested by wood destroying fungi. Until three years ago the final date was the 31st July. However, it has proved unequivocally that the sleeper quality has become better since the date of delivery was advanced.

The red heart-wood of beech is impenetrable for preservatives; however, it posseses no natural durability as for instance the heart-wood of oak or pine. Therefore the 'Specifications for non-impregnated wooden sleepers' of the International Organisation of Railways (UIC-Code 863 V) supplemented by additional conditions of the DB (TL 918,144) provide for a limitation of the proportion of red heart-wood of the sleeper,

which may be approximately one-third of the cross section.

A reduction in the treatability of pine wood can be caused by heavy blue-staining of the sapwood. It is partly due to a blocking of the pits and partly an indirect effect of the mycelium existing in the wood, which causes a slower seasoning of the timber in comparison with unstained timber.

Thus the timber to be treated will show a varying moisture content and blue-stained timber will be 'mature for impregnation' at a later date than unstained. The impregnation maturity of pine wood, however, is necessary for a penetration of the sapwood up to the heart.

However, it is also possible and even easier to impregnate timber heavily infested by blue-stain fungi or moulds with creosote, as it was proved by Lindgren and Scheffer, Bellmann and Francke-Grossmann, and Schulz, but only under conditions of a preceding intensive seasoning. This would mean in practice that unstained and blue-stained timber would have to be seasoned separately. But that would cause additional costs and would be too complicated.

The previously mentioned thorough seasoning of the timber before the impregnation certainly applies also for the other sleeper species, especially when sleepers are to be impregnated with creosote. To obtain the so-called impregnation maturity the DB, who procure non-impregnated sleepers only, have them seasoned in airy stacks for six to ten months, depending on the climatic conditions of the year, under continuous control. The track sleepers are piled up in Z-shaped stacks. The impregnation maturity begins approximately with the moisture content of fibre saturation and generally sleepers which are mature for impregnation have about 20 to 30 per cent moisture. The moisture content is determined either by weighing of single sleepers or by the copying-pencil method on the cores of an increment borer.

Primarily preservative treatment

Impregnation by the DB with creosote according to the Rueping-process became the standard method early and it has remained so until nowadays without significant changes.

Certain modifications to the impregnation technique were introduced, partly in regard to the treatment of sleepers before impregnation. From 1909 the impregnation of beech sleepers was carried out according to the so-called Double-Rueping-Diagram which is a sequence of a pine and oak diagram. In 1928 it was ordered that the holes for the sleeper screws should be drilled prior to impregnation and from 1930 the application temperature of creosote was increased up to 105° to 110°C. Since 1940 the 'middle-drilling' (four diagonal holes in the middle of the sleeper under-side) is applied to all beech sleepers, which until that date was done only in sleepers which were delivered after the 15th May.

Also the further development of the preservative salts and experiments for improvement were continued. In particular the work of Malenkovic, Wolman and Netsch was fundamental for the invention of the salt compounds on the basis of fluorine-chromium-arsenic (1930) which became known in Germany as U- or UA-salts, respectively, and which found international distribution as Wolman-salts.

Many experiments with different salts and compounds were made by the then Deutsche Reichsbahn since the World War I which were partly finished as recently as the last years. During World War II the sleepers had to be treated with salts because no creosote was available at that time. Regarding the efficacy of the salts used for impregnation of sleepers it can be said that they did not reach the effectiveness of creosote.

The useful life of sleepers which were impregnated with sodium fluoride, Flunax (84 per cent. NaF, 8 per cent. Xylenol, 8 per cent. NaOH) or Zinc chloride was between 12 and 15 years for beech sleepers and between 15 and 17 years for pine sleepers. The sleepers treated with salt compounds of the Wolman-salt type obtained a life in service from 16 to max. 22 years depending on the volume of traffic. It has to be admitted that the absorptions of salt specified at that time were far too small according to our present knowledge.

Further, the weathering of the non-fixing salts and components has to be taken into consideration. Moreover, a certain chemical decomposition of the wood of beech sleepers seems to occur which becomes especially apparent in sleepers treated with Flunax. These are somehow grooved and short-breaking. The explanation might be found in the rather strong alkalinity of that preservative.

Finally, recent investigations by Liese have shown that the salt-treated sleepers from the years before and during the war are severely infested by soft-rot fungi and this seems also to be a significant reason for the relatively short life in service.

After World War II until 1947 it was only possible to treat with salts like Flunax. When creosote became available again some of those sleepers impregnated previously with salt solution were treated once more with creosote. This happened also with reconditioned sleepers which were gained from track renewal. This procedure was partially successful but not in cases where the strength of wood had been weakened by influence of Flunax.

Nowadays the German Federal Railways use as a

rule only creosote for preservative treatment of sleepers; salts are investigated in separate experiments.

The preservative treatment is carried out in two DB-owned and fifteen private plants.

The required absorptions of creosote are for beech sleepers, 145 kg/m^3; pine sleepers 63 kg/m^3; oak sleepers 45 kg/m^3. The treating diagram can be changed under certain circumstances if the sleepers to be treated have a too high moisture content. In this case a boiling under vacuum precedes the normal impregnation. The duration of this boiling process is dependent on the initial and on the desired final moisture content of the sleeper.

The results obtained according to this process are satisfying as far as the reduced cracking and the penetration by oil is concerned. However, disadvantages are the higher costs and the often undesired high creosote absorption.

The German Federal Railways have used the method of drying and impregnation of sleepers with too high moisture only occasionally so far, but they depend on it when sleepers from red oak, which had been bought in the USA, could not be seasoned well enough under the climatic conditions of Germany in spite of a very long seasoning time. They kept a moisture of 40 to 50 per cent.

Experiments have been made repeatedly to improve the Rueping process but without greater success. Thus, by order of the DB, investigations were carried out by the Ruetgers-Werke Co. during the last few years as to whether it would be possible to shorten the rather long treating time, especially for beech sleepers, and also to gain an improved penetration by the use of higher pressure.

So far, the results have shown that the preservative distribution in wood is better by application of an increased pressure of 12 to 16 atm but at the same time a higher creosote absorption is unavoidable. By shortening the impregnation time, however, considerable differences in the preservative retention appeared and creosote distribution became really poor. The investigations are continuing but they will have to be very numerous and over a long period because of the lack of homogenity of beech wood and the possibilities of variation as to initial pressure, oil pressure and impregnation time.

Estimated useful life

Generally, nowadays a useful life is reported for beech sleepers of 40 years, for pine sleepers of 30 years and for oak sleepers 32 years. This takes into account reconditioning and re-using on secondary track. How far the figure for oak sleepers is verified or whether it is only an estimation, it was impossible to find out exactly.

Apart from the general creosote treatment, experiments with water-soluble preservative salts are made, as already mentioned. These started when the so-called "reform-salts" had been developed and appeared on the market.

These salts differ from the previous UA-salts by their acid reaction, better fungicidal and insecticidal thresholds and their higher and controllable fixation. The latter advantages are obvious. The acid reaction makes possible a deeper penetration into the wood due to the diminished swelling of the wood.

Moreover, there is supposed to be a higher efficacy against soft-rot fungi which generally have their optimum of growth in a basic pH.

The pine and beech sleepers treated with acid salts are in experiment tracks in climatically different parts of the Federal Republic. A judgement of their efficiency in comparison to creosote impregnated control sleepers will not be possible before 10 to 15 years. The introduction of a general sleeper treatment with salts at the DB beyond the scope of experiments is impossible as long as salts increase the electrical conductivity to such extent that the perfect functioning of the electrical signal system is not guaranteed under any circumstances without additional provisions for insulation. However, this situation could change if salt compounds with a lower conductivity were developed and if the DB would change from the electrical to the system of wheel-counting device. Moreover, the question of using creosote or salt is a decision of economy. At present creosote is relatively cheap and available in sufficient quantity in Germany. Also data from many years' experience exist for creosoted sleepers all over the world. The use of salts for the primary preservative treatment of sleepers must be taken into consideration when it can be proved that salt impregnated sleepers could obtain a similar useful life as creosoted sleepers and that economical advantages can be gained by application of water-borne preservatives.

In the scope of the experiments with preservative salts another process was tested which was developed by the Dr. Wolman Co. and is called in Germany the "hot-wet-process". In this procedure, which is a kind of modified Boulton-process, the timber is first steamed during two to three hours until the surface temperature of the wood is about 70° to 80°C. After this an evacuation to about 30 Torr* follows during three hours. Then it is flooded while the vacuum pump is still working and finally a pressure of 8 atm. is put on the solution until there is no longer any appreciable absorption.

The results obtained by the hot-wet-process are good.

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* Pressure in millimetre mercury column, 1 Torr = 1 mm. mercury column

Sapwood without tyloses and disturbances in structure, such as knots, can be impregnated practically through-and-through even with 40 to 60 per cent of moisture. At higher moisture content, the penetration of preservative decreases more or less with increasing distance from the sleeper ends and from the screw holes. However, generally further penetration occurs by diffusion later on. The salt enters also into the heartwood but generally it does not penetrate it completely.

The hot-wet process will not be used in general at the DB. In special cases, for instance, if windfall wood has to be used during summertime, the special process for wet wood can be valuable.

The costs correspond to those of the creosote treatment for seasoned beech sleepers and are slightly higher than those for seasoned pine sleepers. However, it would still be possible to reduce them.

Secondary preservative treatment

Seldom is the whole timber impregnated through-and-through by the primary preservative treatment. The red heartwood and the zones with tyloses in beech sleepers are not penetrated by creosote and also the heartwood of pine and oak wood resists to an impregnation. As long as the non-impregnated wood is surrounded by a layer of protected wood there is no danger. But cracks appear and these make it possible for the wood-destroying fungi to enter the interior of a sleeper.

To prevent this, to give additional preservation to the sleeper in its exposed parts and to complete the primary preservative treatment, large scale experiments with two different kinds of preservative have been made during the past eight years by the DB. A preservative salt called Wolmanit-TS and a coating made out of creosote, tar pitch and filler material called Diufix have been used. In both cases more than 500,000 sleepers have been treated.

Wolmanit-TS

The idea of a secondary preservative treatment of sleepers with salts is based on a proposal by Wolman in 1929. However, the first experiments by the DB were not made until 1952/53. These have led to the development of the salt Wolmanit-TS and to the technique of treatment used during the last few years for after-treatment in reconditioning plants and in track. The preservative is a compound of hydrogen fluoride, monofluoride and chromate; arsenic is not contained. The feature of the preserve is a good diffusion and a limited fixation.

The application takes place in Germany mainly in sleeper reconditioning plant. Salt cartridges are placed in the old screwholes, i.e. for each rail support four pieces : eight pieces with a weight of 200 g. per sleeper. Then the holes are closed with wooden stoppers. In addition, the adzed surface of the rail support receives a brush treatment of Wolmanit-TS paste with 100 g. salt each before the new bearing-plate is fixed, so that the total amount of salt is 400 g. per sleeper which corresponds to 4 kg/m^3.

At present all reconditionable pine sleepers are after-treated with salt. Beech sleepers are given treatment in the plant at Bottrop. The costs amount to a total of 1.40 DM.

An after-treatment of sleepers in track is carried out practically only with pine sleepers, and that in combination with plugging. Beech sleepers are not yet often plugged in track but here also experiments have been made. Plugged sleepers can hardly be reconditioned later on in the plant since there will not be sufficient firm wood for new screw holes because of the wide plug-holes. Yet it is believed that the sleepers, on account of their improved mechanical strength and of the preservation treatment, can remain in track so long that the after-treatment is justified financially.

Presupposition for this, of course, is that plugging and after-treatment are carried out at a time when the sleepers are still worth a treatment and guarantee the success. This date cannot be fixed exactly, for it is dependent on the volume of traffic and the local circumstances. The costs for plugging and after-treatment with preservative are on average 8.80 DM per sleeper according to the experiences so far. The after-treatment itself costs only about 1.40 DM, which is equal to the expenses in the reconditioning plant. In comparison, a sleeper renewal in track and the reconditioning in plant amounts to 16.50 DM per sleeper with no regard to the costs of transport.

The plugging, combined with the secondary preservative treatment and also after-treatment without plugging, has been applied in various procedures. It would take too long to discuss the many variations which differed especially in the manner in which the salt was introduced into the wood. Only the method used at the last experiment may be reported.

> The bearing-plate is loosened and the surface of the rail support of the sleeper is adzed. The old screw holes are drilled wider for the plugs, and for each rail support two additional holes of 32 mm. and 30 mm. depth are drilled according to Fig. 1. Slit-plugs from beech wood, which are treated with a high-concentrated, good diffusible salt, are driven into the sleeper and 75 g. salt paste (Wolmanit-TS) is poured into each additional hole. Each surface of a rail support receives finally a brush treatment with about 100 g. paste.

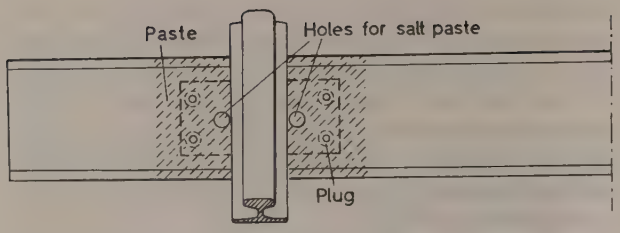

Fig. 1. After-treatment of sleepers in combination with plugging in track.

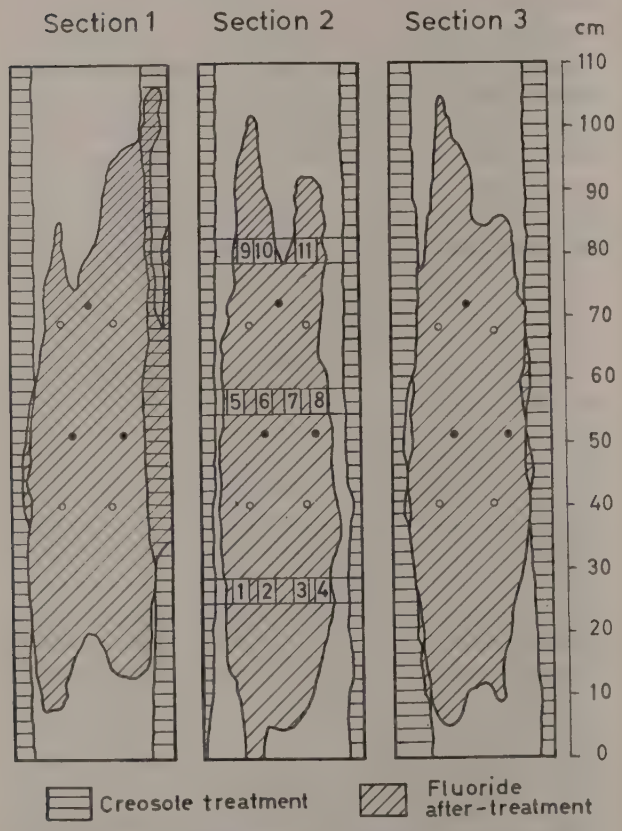

Fig. 2. Effect of after-treatment of sleepers in a creosoted pine sleeper three years after application—longitudinal sections in about 3 cm. distance (Bundesanstalt fur Materialprufung, Berlin).

The amount of preservative in the plugs, which were considered as a depot and source for diffusion, had been varied between 7 and 30 g. per plug. By way of trial a salt plaster in shape of a thin salt treated pad of foam material was used instead of paste coating. The amount of salt per sleeper should be 400 g. corresponding 4 kg/m³.

The efficiency of the secondary preservative treatment is based on the physical principle of diffusion. Since older sleepers have at all times enough moisture in their interior for this, it is possible that the salt disperses through the area of the rail support, like Fig. 2 shows as an example. Naturally, the diffusion follows most easily the zones of highest moisture and since wood attacked by fungi normally has a higher moisture content than other, the main purpose of the after-treatment with salt, to kill existing decay, is obtained as far as the content of fluorides, converted in NaF, is about 1 kg/m³. As a rule this is the case in the surroundings of the screws, as the following Table 3 shows.

A complete penetration of the sleeper by the salt does not happen but this is not expected. It might, however, be undesirable in regard to the electrical conductivity.

The diffusion takes place more regularly in the relatively simple constructed pine wood than in the more differentiated and inhomogeneous beech wood. Heartwood is surprisingly penetrated to an intensive extent by the diffusing salt as also Borup and Rennerfelt showed and creosote existing in the sapwood does not impair the diffusion as far as there is enough moisture, as could be proved in another connection.

The German Federal Railways have initiated a committee of distinguished scientists in the field of wood preservation to investigate the efficiency of the secondary preservative treatment of sleepers.

According to the report of the committee, the question regarding the economy of the after-treatment of sleepers has not been clarified yet because the main problem, i.e. the reasons for destruction of wooden sleepers, is not yet solved. Gneist reported on this problem. His information, however, is only based on a result of sorting done by visual inspection in the sleeper reconditioning plant and not on scientific investigation. Therefore, it cannot be recognised as applicable. To judge whether and to what extent a sleeper has been destroyed by decay is extraordinarily difficult and complex and the question about the primary cause often cannot be answered since the individual factors, as for instance cracks, mechanical wear, decay, and wood deterioration due to corrosion, can overlap and increase and often do. Thus there is a very close and essential relation between the biological and mechanical destruction. Already a minor growth of wood destroying fungi results in a considerable loss of strength of the wood.

According to Liese and Stamer a loss in weight of the wood of only 10 per cent. due to attack by fungi caused in experiment a decrease of the compressive strength nearly 50 per cent. A reduction of strength of sleeper wood due to influence of fungi below the bearing plate in the area of the sleeper-screws has always to be considered as critical and depending on its extent it soon will lead inevitably to the sleeper-screws becoming loose under the continuous load cycle.

In addition there is the influence of the corrosion of

the sleeper-screws and of the bearing plate. Although it is known that corroding iron causes decomposition of wood, however, no exact data exists on the basis of which the extent of the destruction in relation to time and other factors could be stated.

Diufix

An important factor for the destruction of wooden sleepers is undoubtedly the cracks in the wood. They can expose wood which was not impregnated in the interior of the sleeper and cause infection by wood destroying fungi. The intensity of the formation of cracks depends on the degree of shrinkage of each individual species, of the climatic conditions, of the position of the sleeper in the stem, of the mechanical wear and biological attack, and of the service life in track. Of the domestic sleeper species it is beech wood which shows the greatest tendency to cracking. Large cracks which are generally due to stress and emanate specially from the sleeper heads can reduce the hold of the screws. Smaller cracks are mostly seasoning cracks which develop due to shrinkage of the wood below fibre saturation. Against large cracks only mechanical means are effective, as for instance S-irons, bolts and straps. Smaller cracks can be reduced or even partly prevented when one succeeds in limitating the absorption and loss of moisture of the sleeper to such an extent that swelling and shrinking of the wood is substantially reduced. This is attempted by the application of the sleeper coating, Diufix.

Diufix consists of a spreadable mixture of creosote, tar-pitch and organic filler materials. The sleeper receives a coat on the cleaned upper side of approximately 1.1 kg. The timber should not be wet and consequently the application is limited to the dry season or dry days of the year. The paint is applied either with the aid of a tar sweeper or the specially developed application equipment. The costs amount to a total of DM 1.40 per sleeper.

Beech sleepers only were coated up to the present time. The coat should be applied when the effectiveness of the fresh creosote, which decelerates the moisture absorption of the sleepers, has diminished, when the sleepers do not bleed creosote any more and when the cracks increase. After three to five years of service life is considered the most suitable time for application at present. Since the agent can cover small cracks only it is considered obligatory by the DB that the treated sleepers are first strapped, so that no larger cracks can develop. This requirement cannot be realised at present since only approximately 60 per cent. of the sleepers envisaged for coating treatment are strapped.

The opinions in practice on the success of the agent differ. This is mainly due to the fact that the results sometimes differ considerably and that an objective estimation is rather difficult because of the lack of uniform evaluation measures. Furthermore the oldest test tracks are not more than six years old. However, the problem is being scientifically investigated at present and the extensive and long-lasting tests will probably provide the first exact data for the evaluation of the agent in the near future. After that it will be decided whether an after-treatment of the sleepers with agents on a basis of creosote and tar-pitch show technically and economically successful results and whether the treatment can generally be introduced at the DB.

Wooden transmission poles

The DB use wooden poles for telephone and circuit lines.

The DB always purchase only raw, debarked poles because only in this way the quality and soundness of the timber can be judged satisfactorily. The poles are seasoned in a few storage yards installed in private impregnation plants and subsequently impregnated under control by pressure tank process. Usually, pine poles are treated with creosote and spruce poles with salts. The impregnation of pine poles is carried out according to the Rueping diagram.

For the impregnation of spruce poles as complete a vacuum as possible is required. About 25 Torr are considered necessary. However, it is also of importance to retain this vacuum for a certain period and it should be maintained until the timber has been flooded completely. The subsequent pressure of 8 atm. must be maintained until no further absorption of the solution is possible, in order that spruce wood, which is rather difficult to impregnate, will absorb as much of the solution as possible. The required retention of salt is controlled by the concentration of the solution. In order to ensure that the treating process is not finished prematurely any excess absorption of normally concentrated solution will be rebated to the impregnation plant. According to a certain opinion a degasification of the preservative solution is considered necessary to obtain a deep penetration into the timber. Investigations of this hypothesis have commenced.

Until the adoption of the empty-cell Rueping process a full-cell treatment with 300 kg/m^3 was applied. From about 1910 to 1938, 60 kg/m^3 were used for treatment according to the Rueping process and only after that was the required absorption increased to 90 kg/m^3. The specified amount of salt varied between 4 and 6 kg/m^3. During the past three years only the new acid UA-salts have been used.

According to the regulations for the treatment of pine poles a complete impregnation of the entire sap-

wood with creosote down to the heartwood is required. The last years have shown, however, that this regulation frequently is not complied with and also has not been enforced in former times.

On the contrary, creosoted poles often show more or less wide sapwood zones around the heart, from a width of a few millimetres up to centimetres which are not penetrated by creosote. This can be found with newly impregnated as well as with old, removed poles.

In the case of old poles this is attributed to the deficient impregnation of the sapwood with the then lower absorption of 60 kg/m^3 and the pressure period of only 30 minutes. Since 1939 or rather since 1948/49 impregnation has been carried out with 90 kg/m^3, using a pressure period of 120 minutes; nevertheless even then, similar or more or less incomplete impregnation results occur which have caused different consumers to increase the creosote absorption to 120 kg/m^3. Bellmann attributed the insufficient impregnation of the pine sapwood to the existence of a so-called 'heart-wood conversion zone' which is supposed to be sapwood but cannot normally be impregnated. When using the heartwood reagent (Benzidin), however, heartwood cannot be indicated by colour in such areas and the exact proof of the formation and extent of a heart conversion zone is still lacking. There certainly will be a transition stage from sapwood to heartwood but whether such a sapwood conversion zone—as it should be called more logically—extends over one or just a few rows of cells is unknown. For the consumer it should be remembered, however, that those sapwood parts adjacent to the heart and not included in the creosote impregnation are not heartwood (with heartwood's natural durability) but sapwood, as investigations have shown. Thus they are the most vulnerable areas to destruction by fungi, as may be seen in removed poles. This lack of preservative results in ring rot and heart rot. According to statistical findings on a large number of removed poles about 76 per cent. of creosote impregnated poles fail due to interior decay. It can be assumed that a deficient penetration of pine poles with creosote will be due essentially to the fact that limited unseasoned sapwood parts which could not be impregnated must have existed adjacent to the heartwood. Therefore the DB place particular value on good seasoning of their poles.

Impregnation tests with pine poles using acid UA-salts have shown good results concerning the depth of penetration of the preservative. A penetration by diffusion of fluoride of about 1 to 1.5 cm. into the heartwood was proved by a Zirkon-Alizarin reagent (corresponding to 0.2 per cent. NaF). This was also found with pine sleepers which were subjected to a primary impregnation with acid UA-salts.

Salt solutions also do not penetrate deeply into spruce wood by the normal pressure tank process and 1·5 to 2 cm may be the average depth of penetration. Depending on the composition of the salt, there still then occurs a certain diffusion before the salt fixes and the pole seasons. An answer is still awaited as to whether the hot-wet-process, with which promising tests have been carried out, will render possible real progress in the field of spruce pole impregnation.

The expected mean service life of creosoted poles is about 30 years and of poles impregnated with UA-salts of the older type between 20 and 25 years. It is hoped that the acid UA-salts will prolong the service life to approximately 30 years. The statistical findings concerning the service life of poles, showing certain inefficiencies and varying results, should not be taken into consideration here, moreover, since any calculation will always apply only to a certain number of poles, due to the already mentioned change in preservative absorption and the different processes. This applies especially for the increased number of poles after-treated in the years after the war.

Secondary treatment of poles

The most vulnerable part of a pole to wood-destroying fungi is the earth-air zone because there the micro-organisms have especially favourable living conditions and with salt treated poles the most intensive leaching occurs at those parts. With after-treatment preservatives in the form of salt-filled bandages it is possible to supplement the primary impregnation and to prevent or kill, respectively, decay. The development of such preservatives started about 30 years ago and has reached a high level today.

During the last six years extensive investigations on the effectiveness of after-treatment preservatives have been carried out in three scientific institutes on behalf of the Vereinigte Deutsche Elektrizitätswerke, which have led to valuable results and new knowledge.

For the large scale experiments two types of model-bandages with defined amount of effective substance and also six different types of commercial preparations have been used for a great number of stumps and long poles. The model-bandages were based on a so-called N-salt (NaF) or on an U-salt (fluorine-chromium), respectively. In addition the influence of rain and the movement of moisture in poles were investigated. After one, three and five years comparative evaluations were carried out. The essential findings were that after five years of experiment a sufficient protection is still guaranteed against wood-destroying fungi in the area of the bandage and that a duration of efficiency of six to eight years, under certain assumptions even of ten years, can be expected.

With the model-bandages, the N-saltpaste in comparison to the U-saltpaste showed an unequivocal

superiority in the depth of penetration and in the dispersal throughout the wood even after five years of experiment. A high concentration of fluoride of the U-salt remained in the outer zone of the pole. The results of the experiments show that easy diffusing after-treatment preservatives on the basis of sodium fluoride or hydrogen-fluoride should be used for poles with low moisture content of wood, such as younger creosoted poles. Contrary to that, for salt-impregnated poles, bandages containing U-salt should be applied in order to compensate the loss by leaching of the primary treatment salt in the periphery layers of wood of the pole by a high and partly fixing content of preservative.

The carefully applied outer packing of the bandage on the pole is necessary to avoid a loss by leaching and to render possible a fully efficient after-treatment. A complete coating of bitumen as v. Kruedener suggested showed the best results. Due to the experiences and the new knowledge gained it is now possible to have commercial after-treatment preservatives tested.

Preservation of freight wagon timber

The use of preservative treatment of wood for freight wagons is of considerable importance. Here it is necessary to differentiate between open and covered freight wagons. Until 1957 the flooring of all open wagons, which was mostly of pine wood, was treated with preservatives. Today the application of wood preservatives is limited to certain wagon types because the mechanical wear of the floors is so heavy that the expected prolongation of service life by wood preservatives cannot be realised. Therefore one has to use the harder and more durable oak wood instead of impregnated pine planks or even steel-flooring in cases of very heavy wear. Because of this the number of workshops in which impregnating takes place has been reduced from eleven to two.

According to the specifications of the DB for freight wagon timbers creosote is used as a wood preservative, application being carried out according to the so-called in Germany) Gugl-process, which is a hot-and-cold bath. The temperature of the hot bath is 110°C. and of the cooling bath 80°C.

The duration of treatment depends on the initial moisture content of the wood and also on the required absorption of preservative by the wood. The creosote retention should be 60 kg/m^3 in average. In previous years impregnation took place according to the Rueping-process. Then, however, it was decided to apply the hot-and-cold bath because the requirements for non-bleeding of timber apparently could not be realised by the Rueping system. It was also easier and cheaper for the single workshops to treat the timber on site.

Experiments with water-borne preservatives were also made.

For the use of beech timber the possibility of treatment with dimension stabilisers, such as synthetic resins and paraffin is important in order to limit the heavy swelling and shrinking of this wood species. Such tests are running at present.

For covered freight wagons no wood preservation was applied formerly for hygienic reasons and because of the smell of creosote. Since 1955 veneered plates of beech wood, 25 mm thick for the end walls and 18 mm thick for the side walls of wagons, have been used instead of the frequently not tightly fitting wooden boards. The plywood is glued, weather-proof and provided with a film of phenolic plastic for surface protection. The edges are specially treated.

During the last few years it has been shown that destruction by fungi occurred in the plates because moisture could penetrate on account of damage to the surface film. Therefore a concentrated wood preservative is now added to the glue. The expenses are relatively low. So far, it is not possible to say definitely if it has proved successful.

At present plates have been used in about 40,000 freight wagons; the total required number will be about 85,000 wagons.

Other applications

Wood preservation in above-ground buildings can be prophylactic or combative. The prophylactic preservation against fungi and insects is obligatory for all new buildings of the DB. Among the fungi it is used especially against *Coniophora cerebella* which causes great damage in new buildings and *Merulius lacrymans* which, however is more common in older buildings and which developed a great deal after the last war. Among the insects the house longhorn beetle (*Hylotrupes bajalus*) is a great danger particularly in areas near the coast but also other parts of Germany are heavily affected regions, as for instance South-west Germany.

In fighting the longhorn beetle during recent years about 41 per cent of the damage in DB-owned buildings was dealt with at a cost of about DM 2 million. Further DM 5·5 million are considered necessary for the next years. The DIN-Norm 68·800 'Wood preservation in over-ground buildings' governs wood preservation work. The selection of a preservative is left to the contractor. Sometimes, salt or oil is specified. However, it is essential that the preservative has been officially tested and approved. These are listed in the 'Register of wood preservatives' which is issued annually by the 'Testing committee for wood preservatives'. In order to obtain careful and conscientious work in wood preservation a guaranteed quality is aimed at, as is the case in other branches of the building industry.

A PROGRAMME OF CONTROL FOR PHARAOH'S ANTS

By BRIAN C. KESTERTON *

Pharoah's ants are difficult to control because of their tendency to live in cavities where direct treatment is impracticable. This article describes a method of eradication with chlordane that resulted in considerable success.

PHARAOH'S ants (*Monomorium pharaonis*) have in the past provided some of the most difficult problems which industrial pest control contractors have had to solve. Within the last decade or so new materials have enabled much better results to be obtained against these insects, but prior to this period, control of Pharaoh's ants was not generally as satisfactory as was desirable.

Pharaoh's ants are considerably smaller than the varieties of ants which infest gardens and open land and they are lighter in colour. They are essentially pests of building interiors and if they are found outside one would expect to find a subterranean heating duct in the vicinity. One of the facts rendering their control difficult is that nests are hidden away behind tiles, in cracks and crevices of brickwork and in similar situations where they cannot be treated directly. These insects are usually found in warm areas—centrally heated buidings are particularly prone in infestation.

They are commonly found in restaurants, laundries, bakeries, blocks of flats with central heating systems, and particularly in hospitals. The larger hospitals with their complicated system of heating ducts running under passages, wards and other departments provide an ideal habitat for the insects. An infested building where the infestation has been allowed to develop will house several thousand ants causing considerable chaos. The ants swarm over foodstuffs, in desks, on equipment, they are sometimes found in freshly laundered linen and their presence causes a large number of complaints when they are found.

Fortunately the introduction of insecticidal lacquers and some of the new synthetic insecticides has provided the materials to ensure more effective control of these pests. Before these new materials were available control was usually attempted by the use of liquid and powder insecticides which were effective against other crawling insects and which provided local temporary relief against Pharaoh's ants, but which did not usually provide the long term efficiency desired. Better results were sometimes obtained with the use of poison baits but this was a laborious method and had to be continued over a considerable period of time to eradicate an infestation.

Treatment programme

The following is an account of a treatment carried out against Pharaoh's ants in a medium large hospital in the London area. There is now nothing particularly novel about the control methods described but it is perhaps interesting that the treatment was originated about eight years ago and that it has been possible to keep some check on the results obtained.

In the spring of 1953, the management committee of the hospital in question was extremely concerned about an infestation of Pharaoh's ants throughout the hospital buildings. This infestation had been established for at least six years and some members of the hospital staff reported that there had been Pharaoh's ants in the hospital during the early war years. Almost all departments were affected to some degree and in some wards, in the kitchen and laundry the ants were present in large numbers. In this particular case local temporary relief was being obtained by periodical spraying with liquid and powder insecticides and with the use of poison baits, but the overall situation showed little improvement. The management committee called in

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the D.S.I.R. Pest Infestation Laboratory, and as a result of this laboratory's investigation, report and recommendation decided that the hospital should be treated throughout with chlordane.

The hospital consisted of a main central block consisting of wards, main kitchen, offices and medical departments with several outlying buildings including more wards, clinics, offices and a nurses' home. Most of the buildings were connected by means of heating ducts or passages running under the floors of the buildings and underground from building to building. These ducts originated in a boiler house about 100 yd. away from the main hospital block.

For the purpose of the insecticidal treatment it was decided to divide the hospital into sections rather than to attempt to treat the whole hospital in as short a time as possible—this meant some saving in money to the management committee, and also ensured that the necessary disruption of daily routine could be spread over small sections of the hospital one-by-one rather than have a period of constant upheaval throughout the entire premises.

Chlordane, the selected insecticide, was generally used as an emulsion concentrate diluted with water to produce a 5 per cent. wt/vol. chlordane spray. In those places where it was very important to avoid any staining risk the insecticide was applied in odourless kerosene. The first areas treated were the sub-floor and subterranean heating ducts because these were heavily infested and provided the means of access from one department to another. Some doubt was expressed as to the wisdom of this as it was feared that treatment of the ducts before treatment of the departments above would tend to drive the ants from the ducts into the departments. In fact this did not happen.

Heating ducts under hospitals vary considerably in size; sometimes it is possible to walk along them quite comfortably and sometimes it is impossible to get along them at all. In this hospital the main duct could be walked reasonably comfortably; off the main duct there were subsidiary ducts and these were large enough to crawl along; off the subsidiary ducts there were smaller ducts and it was not possible to get along these at all. The main duct ran from the boiler house to and under the main hospital block and the subsidiary ducts ran under ground floor wards, hospital departments and to other buildings.

Liberal spraying

Treatment of the main and subsidiary ducts consisted of spraying all wall and ceiling surfaces, through which pipes passed, quite liberally with the insecticide. In addition at intervals of 10-15 yd. a complete band of chlordane about 4 ft. wide was sprayed down both

A pest control operator treating a duct under a hospital building with chlordane as part of a programme against Pharaoh's ants.

walls, across the floor and across the ceiling of the ducts. As far as the very small ducts were concerned these were treated with a fogging machine and this method appeared to be reasonably effective except in those cases when there was a draught blowing in the opposite direction to the machine. It was not possible however to treat some of the very small ducts as completely as was desirable. Some of these ducts ran underground from building to building for considerable distances and where possible these ducts were exposed at intervals by lifting flagstones covering them and treating the areas exposed with chlordane in addition to treating both ends of the duct with sprayer and fogging machine.

After the initial treatment of the ducts, contrary to the opinion expressed about an increase in the number of ants in departments above the ducts, there was a vast improvement in the state of infestation throughout the entire hospital and a large reduction in the number of complaints about the presence of Pharaoh's ants. An interesting side effect of the treatment was that when the main duct was examined about a week after treatment about a hundred dead oriental cockroaches were found although there had been no complaints about these insects from the departments above and their presence in the duct had not been suspected.

After the completion of the treatment in the ducts the remainder of the hospital was treated in sections at weekly intervals. Generally, chlordane was applied as a complete band around each department, ward and

kitchen at skirting board height with additional treatment to all areas where pipes passed through walls or floors, where there were radiators, sinks, cooking apparatus or other equipment likely to provide harbourage for the ants. Particular attention was also paid to tiled wall surfaces as the spaces behind tiles sometimes provide suitable nesting sites for Pharaoh's ants.

Infestation of wards

Several of the departments could not be satisfactorily treated during the working week and special arrangements had to be made to treat areas such as the main kitchen and laundry. The kitchen was treated at night when it was out of use and the laundry at the weekend for the same reason. The hospital management co-operated fully during the whole of the treatment and this co-operation was certainly a considerable contributing factor to the success of the operation. Most of the wards were treated on the lines described whilst occupied by the patients, care being taken to avoid misting the spray. However in those cases where there had been considerable trouble with the ants, the management arranged to empty the wards of patients for a few hours in order that operators could apply the material more heavily than would have been possible if treatment had been carried out whilst the wards were occupied. This additional work for the hospital staff was considered to be well worth while if there was a chance of eradication because of the problem these insects present in wards, infesting patient's beds and lockers. Pharaoh's ants have been found even between the plaster cast and limb on patients who have been recovering from a broken leg or arm.

The initial treatment throughout the hospital took about four months to complete working one day a week. At the end of this time every department had been treated although not necessarily every room. In those instances where buildings had not been found to be infested the treatment was confined to the ground floor and the ducts beneath.

After the initial treatment had been completed the entire process was repeated—the ducts were treated again and the departments were treated again although not quite so extensively as in the first instance as it was not considered necessary or desirable to empty wards of patients. This pattern of repeating the original treatment was continued for about two years although the interval between operators' visits to the hospital was extended from weekly to monthly with a consequent reduction in the cost of the treatment. Obviously as a result of this each department was treated less frequently than in the first place but by adhering to the original programme each department was treated at regular intervals which might not have been the case if the operator had called at the hospital every month to carry out a general service against Pharaoh's ants, using his own discretion as to which departments he treated.

The results of this treatment were vastly superior to results which had previously been obtained by the contracting firm in similar situations using other control methods. The improvement after the first treatment of the ducts was impressive and emphasized the importance of sub floor treatments in conditions where these are possible. For three years after the first complete treatment of the hospital no evidence of *Monomorium* infestation was found and no complaints about the presence of these insects reported from any department in the hospital. During the period three to six years after the completion of the first treatment throughout the hospital, there were three instances of local infestation by Pharaoh's ants. The areas concerned were treated again with 5 per cent. chlordane with entirely satisfactory results. Nearly seven years after the initiation of the chlordane treatment there was a heavy infestation in the nurses' home, an isolated building with its own heating system and boiler house. It is interesting that this building was one of those which was not originally heavily infested and perhaps on this account it had not received as much attention as some of the other departments where infestation was originally heavy. The rooms in the nurses home, the ducts beneath and the boiler house were sprayed with chlordane, and this treatment again proved completely effective.

Long-term results

After three years of apparently complete freedom from Pharaoh's ants it was disappointing when the insects began to appear again in the hospital. There is a very slight possibility that the ants were reintroduced to the hospital in goods from suppliers, but it is more likely that some ants had managed to survive the original treatment in one of the areas which was difficult to treat, for example, one of the very small ducts, and had gradually spread from this area.

However, the comparatively intensive use of chlordane in this hospital did mean that the problem of *Monomorium* infestation, previously the cause of considerable worry and additional work, could be forgotten by the hospital staff for many years and there would appear to be no reason why these insects should ever be a problem again in the hospital, provided check inspections are made from time to time and local infestations dealt with immediately if and when they occur.

New Zealand leading in timber preservation

NEW ZEALAND is leading the world in timber preservation, said Mr. C. W. Pollard, managing director of Henderson & Pollard Ltd., and merchants' representative on the Timber Preservation Authority, recently when he was speaking in Auckland. He said that last year, New Zealand treated 215 million ft. of timber with preservatives, and this was an increase of 40 million ft. on the previous year. This was a 23 per cent. increase.

Timber preservation is, in fact, saving the country at least £10 million a year in overseas exchange, he said, for this is the cost of the timber of equivalent durability to that obtained from preserving our local indigenous and exotic timbers which New Zealand would need to import annually.

He gave the credit for the leading position of New Zealand in preservation development jointly to the Timber Preservation Authority, the scientists who developed the methods of preservation, and to the companies providing the materials and carrying out the treatments.

'Preservation has turned our non-durable softwoods into a very durable timber. Not only is it saving many millions of pounds in overseas exchange, it has given us a product which has resulted in our modern houses having a greater permanence than ever before and, under normal usage, complete immunity from borer attack and fungoid decay.

'One of the most valuable contributions was made by two scientists from the plant diseases division of the Department of Scientific and Industrial Research, Mr. K. M. Harrow and Dr. D. Spiller, whose research resulted in a new and relatively inexpensive form of treatment.

'Research work at present being carried out by the State Forest Service in Rotorua holds promise of further revolutionary improvements, with vast resultant savings to the country.

'However, much more research should be undertaken, and it is a great pity that this work is being retarded by shortage of staff and equipment and, most important, by the lack of recognition by many that science is making a really worthwhile contribution to the future of New Zealand.'

British pesticides in the Common Market

BRITISH manufacturers of pesticides are obviously not shying away from the probability of the country's entry into the European Common Market. Indeed they seem to have anticipated the event: through their trade associations, the Association of British Manufacturers of Agricultural Chemicals and the Industrial Pest Control Association, they have had their feet under the European table since the beginning of 1959 when they became founder members of the "Groupement European des Associations Nationales de Fabricants de Pesticides".

This was emphasised recently in London when the origin and objects of GEFAP, as it is known for the sake of brevity, were described by Mr. D. J. S. Hartt (May & Baker Ltd.) in a talk given to members of the Industrial Pest Control Association. Mr. Hartt, who is the immediate past-president of the I.P.C.A., and its representative on GEFAP, was able to describe from personal experience how the British and Continental associations have been working together to promote the safe and rational use of pesticides.

Wheat bulb fly damage unlikely in 1962

THE RESULTS of routine soil sampling to determine the risk of wheat bulb fly attack indicate that there is little likelihood of serious and widespread damage occurring in the U.K. next spring, says the Ministry of Agriculture. The sowing of winter wheat and barley is reported to be well advanced, and because early sown crops generally escape serious attack, there is added reason for optimism.

In most areas wheat bulb fly egg populations are much lower than usual, and in some parts of East Anglia where attacks are often very serious after fallow, they are the lowest on record. Where moderately high populations have been reported, they have generally been on peat and other light soils and following early potatoes. With certain exceptions, counts have generally been low on fallows. The exceptions are mainly in the East Riding of Yorkshire, but in the Yorkshire and Lancashire Region generally, the outlook seems to be rather less promising than in other parts of the country.

The general advice given by the Ministry is that for crops sown up to the end of October—slightly earlier in the north of England—insecticidal treatment is unlikely to be necessary. For crops sown from November onwards, it is doubtful whether treatment will be needed on heavy land, other than in the East Riding of Yorkshire, but on light land including peats and following potatoes, the use of a dual purpose insecticide/fungicide seed dressing is recommended.

The Ministry has issued a reminder that it has been agreed not to use seed dressings containing aldrin, dieldrin or heptachlor after 31st December, but there are no restrictions on the use of gamma-BHC dressings which, in any case, are probably those most effective on crops sown from December onwards.

Sacks with "built-in" pest barrier

ONE OF THE most urgent problems facing manufacturers of paper sacks for the packaging of foodstuffs, particularly where they are to be exported to tropical regions, is that of infestation. The price of infestation, both in terms of the wastage involved and the preventative measures currently take to help avoid it, is considerable for goods in transit.

As an economic and effective means of combating infestation, Reed Medway Sacks Ltd. have obtained exclusive rights for the manufacture in the U.K. of multi-wall paper sacks incorporating a new insect-repellent closure.

Known as Repellex, the closure consists of creped kraft tape and thread treated with pybuthrin, an insecticide consisting of pyrethrins synergised with piperonyl butoxide. This combination gives a rapid knock-down as well as having excellent repellent properties. Closure materials are treated by the Cumberland Paper Company Ltd.

Studies of the habits of the more common insect pests have shown that in the majority of cases they enter a sack through the end closure and particularly through stitch holes.

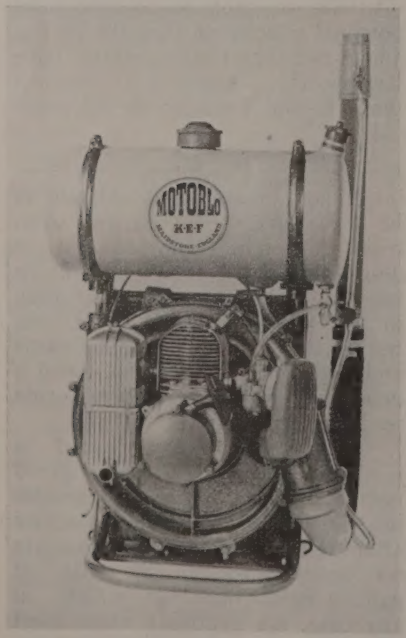
By providing an effective barrier against infestation the Repellex closure is said to reduce loss due to contamination, to prevent deterioration in quality and nutrition value of the sack contents and to eliminate the need for frequent fumigations and sprayings.

Pybuthrin is widely used in the presence of foodstuffs and is recommended by the Ministry of Agriculture, Fisheries and Food for the control of insect pests in stored products.

The treated tape and thread are fully compatible with existing sealing methods, there is no reduction in closure strength and the treated materials will give protection for at least a twelve month period.

Motorised knapsack sprayer modified

IMPROVEMENTS to the Motoblo motorized knapsack sprayer have been designed to give it complete reliability in all climates, conditions and for all world crops, says an announcement just made by the manufacturers.



Front view of the new K.E.F. Motoblo Super-60 sprayer and duster.

The new Motoblo Super-60 manufactured by K.E.F. of Maidstone, England, has an accurate controlled output of up to 6 pints per minute. It emits a jet of fast moving air into which either liquid or dust is automatically fed and which will reach over 25 ft. under still conditions.

The unit has a wide field of application for use in horticultural and agricultural work, warehouses, cargo holds, greenhouses and for all grain stores, silos etc. It is claimed to provide an effective one-man method of controlling all pests and fungus diseases affecting both growing and stored crops and for fumigation work.

The particle size of the mist emitted is in the region of 60 microns. Any water miscible formulation or emulsions or wettable powder or oil solutions can be atomised from a simple non-clog air jacket nozzle. The air is provided by a lightweight fan directly driven by the 3 h.p. 2-stroke engine and because the sprayer is shoulder mounted and manually directed special consideration can be given to awkward places.

The sprayer has a $2\frac{1}{4}$ gallon density polythene sprayer tank. Petrol consumption at full throttle works out at about $2\frac{1}{4}$ pints an hour. The complete weight is $31\frac{3}{4}$ lbs.

Dust-ejector for rabbit control

WITH THE re-appearance of rabbits in various parts of Britain, a new method of extermination which has been announced may result in considerable interest. Produced by Drake and Fletcher Ltd., of Maidstone, and aptly called the Ferret, this portable dust-ejector can be used by a single operator.

A lethal powder such as Cymag, say the manufacturers, is blown into one of the burrow openings. As it penetrates the warren it is seen to escape from other entrances. These are blocked by the operator, using a spade, then the delivery tube is removed and the first opening is closed. The Ferret if carefully handled is claimed by the makers to be 100 per cent effective.

Saving a Scottish cooling tower

WATER COOLING TOWERS are exposed to severe stresses and conditions which encourage decay in the timber. An induced draught tower at Grangemouth on the Firth of Forth recently succumbed to severe attacks of "soft" and "white" rot. One hundred standards of timber are involved in the five cells of this tower which is situated at the works of the British Hydrocarbon Chemicals and its treatment was a major operation.

Millions of gallons of hot water cascade through the cooling towers each day and they are subject to two main damages—"soft rot" and "white rot".

The Grangemouth towers were first of all examined carefully to find out if each beam and post was rotted inside. Timbers which were irremediable were removed, destroyed and replaced with timber which had been pre-treated under pressure.

The remaining timber was given 0.4 lb. of copper retained in each cubic foot to ensure its safeguard against any of the known species of fungi.

The treatment consisted of spraying every bit of wood surface—first of all with copper sulphate and then with sodium chromate. The second spraying fixes the copper sulphate and leads to the necessary insoluble deposit of copper chromate remaining in the timber.

The technique of application calls for extreme precautions to avoid the possibility of copper contaminating the circulating water, which would lead to serious corrosion of iron and steel in the plant which the towers are designed to cool. Not only must the application of the spray be done with expert precision, but the physical hazards of the effect of chemicals on the men's health must be understood and avoided.

Three weeks after the tower had been treated and put on full load the timber was tested to find out how successful the preservative retention had been. The target of 0.4 lb. 1 cu. ft. of copper chromate had, in fact, been surpassed, the test showing that the average deposit in thin cross section timbers was 0.411 lb. 1 cu. ft. and in larger dimension timbers was 1.25 lb. 1 cu. ft.

The work was carried out under the supervision of Mr. T. C. Shooter of the Edinburgh office of Richardson and Starling Ltd., of Winchester, who manufacture the preservation solution.

He said : "Cooling towers present a peculiar and very urgent problem which my firm has studied closely. In Britain the majority of timber used in cooling towers is Baltic Redwood. This is by no means resistant timber and it has been customary to pre-treat it, but the chemicals that were used years ago did not stand up in practice to the exacting conditions and in some cases decay advanced so rapidly that extensive repair work or reconstruction became necessary within seven years of erection.

"Fortunately this has now been overcome and timber pre-treated to-day under pressure with the recently evolved chemicals are impervious to attacks.

"There are, however, many towers throughout Britain and in other parts of the world where decay has started but not yet progressed sufficiently to justify extensive structural work. Our fixation in situ treatment is designed to apply toxic chemicals to such timber for the purpose of prolonging its useful life. We have succeeded in overcoming the technical problems of situ treatment—the process is new and unique, but the chemicals employed have been used for a number of years in the U.S.A. with success and, in this country, are specified by the Central Electricity Generating Board. The cost of application is, in relation to timber replacement, very small and the towers need to be closed down for only a matter of days for the treatment to be applied, as against months for replacement."

Soil Biology. *By Wilhelm Kuhnelt. (Faber & Faber Ltd., 24 Russell Square, London, W.C.1. Price 45s.).*

Since 95 per cent of all insects inhabit the soil at some stage in the course of their development, and such a high proportion of the pest technologist's or control officer's work is devoted to the study of insects, any work on the subject of soil organisms must be received with the closest interest. For the past twenty years, Prof. Kuhnelt and his colleagues at Vienna University have been specially concerned with the ecology of small animals in soils and the role of the fauna in soil-forming processes. Ten years ago much of his work was summarised in a book published in German under the title of *Bodenbiologie*. The present work, to which has been added a great deal of new material, has been prepared in an English edition by Dr. Norman Walker, of the Rothamsted Experimental Station.

After a first chapter devoted to methods of collecting soil organisms and evaluating them, the book provides a very extensive and valuable survey of soil animals, grouped under the headings of protozoa, scolecida (including nematodes), mollusca, annelida, arthropoda, insecta apterygota and pterygota, and vertebrata. A further chapter is concerned with the characteristic properties of soil animals in relation to the conditions of their habitats.

One of the most absorbing parts of this book for the pest technologist will be that chapter which deals with the function of soil animals as a living community, this describing the food sought by various species, the population density, the decomposition processes.

Recommended Common Names for Pesticides B.S. 1831; 1961 *(British Standards Institution, 2 Park Street, London, W.1. Price 15s. net).*

During the last twenty-five years great advances have been made in the development of chemicals for pest control. In the last twenty years, in particular, many new compounds have been marketed on a world wide scale for use in agriculture, industry, medicine and in veterinary practice. The chemical names of these compounds have been, in many instances, too complicated for common use, and short forms of trade names have been devised. As several of these might apply to the same chemical compound, confusion has arisen in the past on the commercial production of products and also in technical literature.

This problem was discussed by the Commonwealth Entomological Conference in 1948. A recommendation made at that time resulted in the formation of a committee to prepare a British Standard list of common names for established pesticides.

It has, of course, been very necessary to keep this standard (B.S. 1831 : Recommended common names for pesticides) up-to-date, and a new revision has just been published by the B.S.I. The last revision took place in 1957, since when the technical committee has continued to hold regular meetings.

There is now a list of over one hundred short and non-proprietary names which are recommended for easier identification of pesticides than relatively long names.

In addition those in the previous edition and its two supplements, all new names which have been announced since are included with additional information concerning these products. In order to pre-empt, as far as possible, their availability as common names in Britain, they have been recorded though not registered by the Trade Marks Registry in London.

The full chemical names and structural formula are given with every compound, together with other non-proprietary names which have been used. The compounds are classified into four groups : insecticides and acaricides, fungicides, herbicides and rodenticides.

The foreword to the specification sets out principles which have been followed in coining the recommended common names. A list of chemicals for which it has been considered that common names are not required is included as an appendix, together with a list of common names considered by ISO though not recommended in this British Standard.

As the new names are approved, they will be announced by the B.S.I. and will appear in a supplement to the revised standard in due course.

Among the organisations which have been responsible for preparing the standard, by means of representation on the Pest Control Products Industry Standard Committee, are the Association of British Chemical Manufacturers, the Association of British Manufacturers of Agricultural Chemicals, the Industrial Pest Control Association, the British Weed Control Council, the Chemical Society, the Commonwealth Institute of Entomology, the D.S.I.R. Tropical Products Institute, and the Ministry of Agriculture.